

Karabiner problems – DHV hearing of karabiner manufacturers on 11. May 2005

The previous history

Due to several cases of breakage to Austrian Parafly karabiners during normal flight, the DHV had carried out preliminary tests to determine the fatigue strength with the Parafly karabiner as well as with other karabiners commonly in use in aviation sports. As a result of these tests it was recognised that the fatigue strength of conventional aviation sport karabiners is primarily dependant upon the respective amount of catch play and the resultant point at which actuation by gravity occurs. When the point of actuation by gravity is lower than the fatigue strength, then there is a danger of breakage. In the range of the catch play the karabiner is stressed as if the catch was open. The karabiners are not designed to be stressed in this manner. The karabiner manufacturers are obviously aware of this as they warn against flights with an open catch and recommend immediate replacement of the karabiner, should it be stressed with the catch open. The maximum catch play of karabiners in common use is unknown since the catch play has to date never been defined. **The preliminary measurements of the operational loading and determination of the fatigue strength with the catch open show in any case that the extremes of operational loading are considerably higher than the fatigue strength of common aviation sport karabiners presently in use, assuming that the catch play is arbitrary.** So that one can assume that only those karabiners are fatigue endurable where the catch becomes actuated by gravity before the fatigue strength ascertained with an open catch is exceeded.

Thereupon on 3rd of February 2005 the DHV demanded from the karabiner manufacturers that they bring documented evidence of the fatigue strength of their karabiners up to the point of actuation by gravity before March 1st 2005, as **otherwise the connecting element would be deemed unsuitable**. The DHV stipulated the following conditions for the documented evidence:

- The documented evidence must be carried out by an accredited inspections office.
- The test must be carried out with open catch.
- The scope of testing must encompass, for the time being at least, three samples of each karabiner.
- The karabiner shall be burdened using 20 mm webbing loops attached at the least advantageous point of application (with the greatest possible torsion arm).
- The burdening takes place with a constant tension ratio of $R = 0,1$ ($F_v/F_o = 0,1$) in the range of the fatigue strength.

Evidence of the fatigue strength up to the point of actuation by gravity according to the prescribed procedure would be supplied if it could be proven that the maximum present point of actuation by gravity lay below the ascertained fatigue strength. Should this apply to only a portion of the karabiners in present use, then the karabiners in present use would have to be inspected to ascertain their point of actuation by gravity.

A decision regarding the necessary amount of safety reserve for the required point of actuation by gravity should first be made after the presentation of the preliminary tests.

As the proof of fatigue strength requires at least 2 million alternation loadings with steel karabiners and at least 5 million alternation loadings with aluminium karabiners, and the tests for each karabiner require at least one week, the date for the proof of fatigue strength was postponed several times at the request of several of the manufacturers.

The meeting

At the meeting of the DHV and the karabiner manufacturers arranged for May 11th 2005, the state of the tests should be reported and procedures determined as to how the fatigue strength of karabiners is to be ascertained in future. At this meeting the following were present; the DHV represented by Hannes Weininger and Rainer Brunn, the head of the inspection laboratories of the company Sincotec and the experimental station for mechanical engineering in Innsbruck Sven Henze and Prof. Siegbert Büsel as well as the karabiner manufacturers Camp, Stubai, Supair, Austrianpin and Finsterwalder.

Mr. Henze initially explained the term fatigue strength and how this can be proven with the necessary safety reserves. He said that the fatigue strength of all safety relevant construction parts is stipulated, for example in the case of elevators, wheel-set shafts etc. Besides this, he discussed the possibility of a temporary proof of fatigue strength. He said however that this proof for karabiners could not be supplied at present, since the necessary detailed insight regarding operational loading was not available. Also a „temporary fatigue resistance“ for karabiners would not be appropriate since it is possible with relatively little effort to achieve unlimited fatigue strength for this relatively simple structural part. Prof. Büsel is consistent with these comments.

In the course of the meeting an agreement was to be reached as to how the fatigue strength of karabiners should be proven in the future. The following was agreed upon:

- In order to ensure compatibility, the fatigue strength of karabiners should also be present with narrow straps.
- The fatigue strength can also be proven with a closed catch. Precondition for this is that the tests be carried out with a defined amount of catch play.










- As regards the point of application one is in agreement that the test arrangement can also be carried out in the middle of the strap support and not at the least advantageous point of application, on condition that suitable safety margins (still to be determined) account for the case of the least advantageous point of application.
- The evidence of fatigue strength should be carried out not only to the point of actuation by gravity of the karabiner, but for the whole range of operational loading.
- Further still, Hannes Weinger in cooperation with Sven Henze should decide within the following two months on the size of the safety margin necessary for the test arrangement and how high the operational loading is to be verified.

Presentation of the fatigue strength test results of the karabiner manufacturers:

Indeed all of the manufacturers present with the exception of the company Stubai had carried out tests, however, no manufacturer (with the exception of the company Finsterwalder) was able to provide evidence of the fatigue strength as demanded by the DHV on February 3rd.

None of the manufacturers, with the exception of the company Finsterwalder, carried out the tests according to the stipulations of the DHV, in that the fatigue strength had to be ascertained with the catch of the karabiner open. Accordingly, the maximum permissible catch play/maximum permissible point of actuation by gravity of karabiners in use was ascertained by none of the manufacturers.

In this respect there exist only the preliminary tests from the company Finsterwalder and the preliminary tests of commonly used karabiners by the inspections laboratory, commissioned by the DHV, which resulted in the following (see also the [test report](#) of the company Sincotec GmbH):

Column No.	1	2	3	4	5	6	7
Type	Number of karabiners tested for fatigue endurance	Breakage at F_b	Highest ascertained sweep at F_b	Estimated mean value of fatigue endurance acc. to testing institute	Highest ascertained point of actuation by gravity	Lowest ascertained point of actuation by gravity	Number of karabiners tested for point of actuation by gravity
 Supair Twistlock Steel paragliding karabiner	3	50 kg	50 kg	approx. 45 kg	95 kg	81 kg	4
 Supair Twistlock Alu paragliding karabiner	5	100 kg	90 kg	ca. 90 kg	85,5 kg	58 kg	5
 Austrialpin Parafly Alu paragliding karabiner	3	30 kg	25 kg	ca. 25 kg	39 kg	14,5 kg	50
 Austrialpin Powerfly Steel paragliding karabiner	5	70 kg	60 kg	ca. 60 kg	67 kg	35 kg	50
 Camp Twistlock Alu paragliding karabiner	2	100 kg	50 kg	50-100 kg	82 kg	73 kg	4
 Austrialpin 3200 Delta Steel hanggliding karabiner	2	170/210 kg	--	ca. 160 kg	214 kg	160 kg	4
 Finsterwalder SIL Paragliding karabiner	12	210 kg	210 kg	210 kg	0 kg	0 kg	--*
 Finsterwalder Quick Out Alu paragliding karabiner	1	---	600 kg	over 500 kg	0 kg	0 kg	--*
 Finsterwalder Pin Lock Alu paragliding karabiner	11	450 kg	450 kg	425 kg	0 kg	0 kg	--*

* as construction-conditioned always actuated by gravity

In as far as the point of actuation by gravity (columns 5 & 6) is higher than the approximate middle value of the fatigue strength (column 4) then with regard to the preliminary tests, there is a high probability that the karabiner is not fatigue durable. As regards the test results for the Supair steel karabiner, Mr Henze and Professor Büsel asserted unanimously that karabiners with these values should not be used.

When asked by the DHV what should be undertaken with the karabiners presently in circulation, all karabiner manufacturers present expressed the wish to remain with the present time operation limitation of 2 to 5 years. The DHV noted this without comment. The DHV also failed to comment on the absent fatigue strength evidence, and as to when this evidence should finally be submitted.

Advantages and disadvantages of the resolved evidence of fatigue strength with closed catch

Advantage:

- The fatigue strength of the karabiner below and above the point of actuation by gravity can be proven with only one test series.

Disadvantages:

- The problem is the unavoidable dispersion of the point of actuation by gravity by the manufacturing of the karabiner. The evidence can only be regarded as valid for the karabiner with the lowest point of actuation by gravity in the test series. Besides, whether a

safety deduction is necessary for the maximum permissible point of actuation by gravity, and just at what level this should be set is still to be determined.

- Determining the maximum possible point of actuation by gravity is more complicated than with tests with the catch open.
- Determining to what value the fatigue strength of karabiners should be proven, as well as testing the new proof technique requires additional expenditure of time. Due to previous insights, evidence of the fatigue strength in the range of catch play, as the DHV has demanded, would be sufficient to prevent pilots being currently endangered.

How should the DHV react?

- The DHV should release the available test results, and draw pilots attention to the risk of karabiners in current use with inadequate fatigue strength. **Most especially, the DHV should inform pilots that the danger of sudden karabiner breakage exists even within the service life stated by the manufacturers, when the necessary actuation by gravity does not take place before the fatigue strength has been exceeded.**
- The DHV should inform the pilots and the manufacturers that it is necessary to determine the point of actuation by gravity for the karabiners presently in use, in order to state whether the karabiners are fatigue endurable or not.
- New karabiners should as of now only be sold, when the maximum point of actuation by gravity of the batch has been individually tested and documented. A suitable batch identification is required.
- Swift determination of how high the operational loading should be, for which the fatigue strength with closed catch has to be proven (dependant upon the permissible hang-in load of the karabiner).
- Determination of the **necessary** point of actuation by gravity for which the fatigue strength is valid for a series of tests with closed catch.
- Recommendation should be given from the DHV to pilots, about how they should proceed as long as the fatigue strength of the karabiner is uncertain.
- The DHV should set a definite deadline, for when the fatigue endurance evidence according to the specified procedures has to be provided for the karabiner, after which date the karabiners without proof of fatigue strength will be grounded.
- The pilots should be warned immediately in the case of the Supair Twistlock steel karabiner, by which a large difference was determined between the fatigue strength with open catch, and the necessary point of actuation by gravity.

Conclusion:

The steel karabiners that broke at relatively low oscillation loadings refute the opinion of many flying schools and the previous opinion of the DHV, that steel karabiners are safer than aluminium karabiners. The fatigue strength of the karabiner is not a question of the material but rather of the construction.



Danger of breakage proven:

The crack in the Supair twistlock steel karabiner arose by oscillation loadings of between 5 and 50 kg. As the point of actuation by gravity in the case of the tested Supair karabiner was above 81 kg, the evidence is provided that these karabiners can break under normal flight conditions with the catch closed.

The Austrialpin Powerfly steel karabiner broke by oscillation loadings of between 7 and 70 kg. This karabiner is less dangerous since with almost all of the tested karabiners the point of actuation by gravity occurred before the fatigue strength was exceeded.

More about the subject of fatigue strength of aviation sport karabiners under: <http://www.finsterwalder-charly.de>

- Karabiner breakage in the Czech Republic... [here](#)
- Insights into fatigue strength of aviation sport karabiners (January 2005)... [here](#)
- Practical tips for checking your own karabiners... [here](#)
- Safety release of the company Finsterwlder GmbH regarding conventional harness karabiners... [here](#)